MUT
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**Seat No:**

# Faculty of Natural Sciences
# Department of Chemistry

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|---|---|---|---|---|---|
| Qualifications | : | ANCDIP/CHENDI | Date | : | 31 May 2023 |
| Subject | : | Engineering/Chemistry I | Venue | : | Bozzoli Hall |
| Subject Code | : | CHMS101/CHEM112 | Time | : | 9h00 |
| Total Marks | : | 113 | Duration | : | 3 hours |
| Full Marks | : | 110 | Examiner/s | : | Mr F.M Makhanya |
| Number of Pages | : | 12 | Moderator | : | Dr L.Q Qwabe |
| Annexure | : | 1 | | | |

Student Name : ----------

Student's Signature : ----------

Student Number : ----------

Examiner's Signature : ----------

Moderator's Signature : ----------

**For office use only:**

| Question Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total Marks | Percentage (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Examiner's Mark | | | | | | | | | | |
| Moderator's Mark | | | | | | | | | | |

**INSTRUCTIONS TO STUDENTS:**

1. Answer all questions.
2. Write all answers in the answer book or question paper provided.
3. Non-programmable calculators may be used.
4. Answer all questions in ink.

**Question 1** **Multiple Choice Questions** **[14 Marks]**

1 1 Which of the following concerning solutions is/are correct? [2]

1. The solvent in a mixture of gases is generally considered to be the substance in greater amount.
2. The solid dissolved in a solution is known as the solute.
3. Solid solutions are called alloys.

a. 1 only

b. 2 only

c. 3 only

d. 1 and 2

e. 1, 2, and 3

1.2 The following representation of an atom is called [2]

$Na\cdot$

a. a Lewis dot structure.

b. an ion.

c. a structural formula.

d. an electrostatic potential map.

e. an ionic bond.

1.3 Which of the following statements is/are consistent with the Arrhenius concept of acids and bases? [2]

1. An Arrhenius acid will increase the concentration of hydronium ion in an aqueous or nonaqueous solvent.
2. All Arrhenius acids are strong electrolytes in water.
3. All strong acid-strong base reactions have the same heat of reaction ($\Delta H°$) per mole of water formed.

a. 1 only

b. 2 only

c. 3 only

d. 1 and 3

e. 1, 2 and 3

1.4 Which of the following is a weak base in aqueous solution ? [2]

a. $HOCH_2CH_2OH$

b. $Ba(OH)_2$

c. $CH_3COOH$

d. $NH_3$

e. HBr

1.5 When the following equation is balanced, what is the lowest whole-number coefficient for $SO_2$? [2]

____ $HBrO_3(aq)$ + ____ $SO_2(g)$ + ____ $H_2O(l) \rightarrow$ ____ $Br_2(aq)$ + ____ $H_2SO_4(aq)$

a. 7

b. 10

c. 8

d. 4

e. 5

1.6 A particular gas exerts a pressure of 4.09 × 104 Pa. [2]

What is this pressure in units of atmospheres?

a. 0.403 atm

b. 4.04 × 109 atm

c. 0.414 atm

d. 0.409 atm

e. 4.14 × 109 atm

1.7 Which of the following is a correct statement of Charles's law, $\frac{V}{T} = k$ ? [2]

a. The volume of a gas varies proportionally with the pressure.

b. The volume of a gas sample varies directly with the absolute temperature.

c. All gas samples of the same volume at STP contain the same number of atoms.

d. The pressure of a gas sample varies inversely with the volume.

e. All gas samples of the same volume at STP contain the same number of molecules.

**Question 2** **Definitions** **[16 Marks]**

2.1 What is the law of conservation of mass ? [2]

2.2 Define the Pauli exclusion principle [2]

2.3 What is Hund's rule [2]

2.4 Define a Polyatomic ion [2]

2.5 What is a metathesis reaction [2]

2.6 Define a Brønsted acid [2]

2.7 What is Stoichiometry [2]

2.8 Define a miscible fluid [2]

**Question 3 Elements, Atoms, Molecules and Ions** **[10 Marks]**

3.1 Draw a basic representation of an atom [5]

3.2 Chromium, Cr, has the following isotopic masses and fractional abundances: [5]
What is the atomic weight of chromium?

| *Mass Number* | *Isotopic Mass (amu)* | *Fractional Abundance* |
|---|---|---|
| 50 | 49.9461 | 0.0435 |
| 52 | 51.9405 | 0.8379 |
| 53 | 52.9407 | 0.0950 |
| 54 | 53.9389 | 0.0236 |

**Question 4 Chemical bonding and Nomenclature [15 Marks]**

4.1 Show a Lewis dot coordinate covalent bond of the formation of the ammonium ion [5]

4.2 Write chemical names/formulas for the following compounds: [10]

4.2.1 $Cl_2O_7$ -

4.2.2 HCN(aq) -

4.2.3 $N_2O_5$ -

4.2.4 $HClO_3$ -

4.2.5 $ClO^-$ -

4.2.6 $MgSO_4 \cdot 7H_2O$ -

4.2.7 $NH_4Cl$ -

4.2.8 $CH_3COONa$ -

4.2.9 Carbonic acid -

4.2.10 Calcium Sulphate Decahydrate -

**Question 5** **Types of Chemical Reactions** **[32 Marks]**

5.1 For each of the following, decide whether a precipitation reaction occurs.

If it does, write the balanced molecular equation and then the net ionic equation.

(a) Aqueous solutions of iron (II) chloride and silver nitrate are mixed. [6]
(b) Aqueous solutions of magnesium chloride and iron (II) nitrate are mixed. [6]

5.2 Acid Base Reactions

5.2.1 Write the molecular equation and then the net ionic equation for the neutralization of nitrous acid, $HNO_2$, by sodium hydroxide, NaOH, both in aqueous solution. Use an arrow with $H^+$ over it to show the proton transfer. [5]

5.3 Oxidation Reduction Reactions

5.3.1 What is the oxidation state of Cr in (a) $K_2Cr_2O_7$ (b) $CrO_3^-$ (7)

5.3.2 Write the balanced half-cell reactions and net ionic equation for the following [8]

$$Fe(s) + Cu_2(SO_4)_3(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

**Question 6** **Chemical Composition and Solutions** **[14 Marks]**

6.1 30 g of $C_3H_8$ burns in air to produce 70 g of $CO_2$. [8]

Calculate the theoretical yield and percent yield of $CO_2$

6.2 If you have 0.0015 g NaCl in a 2500g solution

6.2.1 What is the concentration in parts per million [3]

6.2.2 Given 35000 g of a 210 ppm solution how many grams of salt are present [3]

# The Periodic Table of the Elements (with Electronegativities)